JULY 1961

Soil Conservation

SOIL CONSERVATION SERVICE • U. S. DEPARTMENT OF AGRICULTURE

Growth Through Agricultural Progress

"In a farm horizontally and deeply ploughed, scarcely an ounce of soil is now carried off from it. In point of beauty nothing can exceed that of the waving lines and rows winding along the face of the hills and valleys."

—THOMAS JEFFERSON

COVER PICTURE.—Forty acres of completed parallel terraces before field rearrangement, on the farm of Lawrence Leick, Stratford, Wis., in the Marathon SCD.

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Soil Conservation

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FRANK B. HARPER, Editor

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Engineering Measures

In Farm and Watershed Conservation

By Donald A. Williams

STRUCTURES and earthmoving are indispensable in the combinations of soil and water conservation measures used in treating the country's farms and watersheds.

Conservation planning and treatment calls for employment of a combination, also, of technical skills, including those concerned with the design and building of carefully engineered structures for erosion control and water management. Used in conjunction with conservation vegetative and tillage practices, they include everything from water-controlling terraces to farm ponds and improved irrigation systems on croplands, to flood prevention structures and other works of improvement in small watersheds.

Whether such engineering measures are installed on farm fields or range pastures, on watercourses or elsewhere, they fit together with conservation cropping, woodland, and wildlife practices. They have been developed through research and experience during the last 30 years for bringing about sound land use through erosion control, soil improvement, and agricultural water management. Structures and related measures, designed to the most economical proportions practicable, are included in conservation farm or watershed plans only when the need for them is established. They are used for many purposes, ranging from checking hillside gullies to floodwater retention in small streams.

It is because of their complexity and diversity that the solution of most soil and water conservation problems calls for combined knowledge and experience in soils, engineering, agronomy, range, forestry, biology, geology, and economics. This approach to these problems has demonstrated its soundness wherever they are encountered, whether it is in providing technical aid to farmers and ranchers in their soil conservation districts, through the Agricultural Conservation Program or the Great Plains Conservation Program, or to community organizations in watershed protection projects.

All of these activities in which the Soil Conservation Service has assigned responsibilities require substantial engineering services—in major proportions where irrigation, drainage improvements, reservoirs, or other water conservation measures are stressed. Perhaps the most significant part of the national action program of soil and water conservation from the engineering standpoint is small-watershed development — already totaling between 600 and 700 projects being planned or in construction—because it involves more dams and other structural work for flood prevention.

Conservation engineering skills run the gamut from cartography to construction, from geology to streamflow forecasting from cooperative snow surveys, in which Service engineers have pioneered in the West. They include irrigation, drainage, flood prevention, and erosion-control engineering, and soil mechanics. For many years, also, the Service's agricultural engineers and other technicians have joined machinery manufacturers, farmers, and research specialists in search of tillage, earthmoving, planting, and other equipment adapted to conservation farming and construction needs.

Conservation measures that have been installed by soil conservation district cooperators and other farmers reflect the major proportions of the engineering technologies involved. As estimated to date, they include: More than 1⅓ million miles of terraces and diversions; 1,100,000 farm ponds; approximately 1 million acres of grassed waterways; 35,000 small irrigation reservoirs and 55,000 sprinkler-irrigation systems; improved water application on nearly 11½ million acres; proper irrigation-water use on 4¼ million acres; land leveling on more than 6 million acres, and land grading and smoothing on nearly 3 million acres; water management and control practices on almost 25 million acres; and wetland development for wildlife on about a quarter of a million acres.

Installations in watershed and flood prevention projects, meanwhile, include approximately 2,000 floodwater-retarding structures and 1,650 miles of stream-channel improvement work estimated as completed July 1, 1961. Some 20 group irrigation and drainage improvement jobs include additional canal and ditch construction, stream-channel improvement, and other measures.

Techniques continue to be improved by the Service in all aspects of conservation engineering, better to meet the growing workload in this field.

A New Look For Terraced Fields

By James J. Coyle

INCREASING numbers of farmers are finding they can protect their fields by using a new parallel terrace layout that causes them little difficulty in operating their farm machinery.

Few farmers question the good that terraces do in reducing erosion by controlling the flow of water down sloping, cultivated fields. But some landowners have hestitated to install them, because of the difficulty of farming some conventionally terraced fields with the large equipment now commonly used.

This difficulty comes about when the area between two terraces is wider at some points than at others, resulting in point rows that do not extend the full length of the terraces. To work these rows, the farmer must turn his equipment in the planted area. This was not a major problem in the days of horse-and-mule farming, but turning with large tractor equipment not only takes time but also causes damage to crops when it must be done in the planted area.

There are no point rows when the distance between two terraces is uniform throughout their entire length. Each row extends the full length of the parallel terrace, and all turning can be done at the ends outside the planted area.

It seldom is possible, however, to have all terraces in a field parallel. Normally, the parallel terraces are in groups of 2 to 10 or more, with the odd-shaped terrace intervals limited to the areas between groups of terraces. On most fields, this means that point rows will occur in only one or two places

Note:—The author is agricultural engineer, Soil Conservation Service, Washington, D. C.

Part of 100 acres of parallel terracing and stripcropping on Tracy Garrick farm, Cope, S. C.

instead of between all terraces. The parts of these odd-shaped areas where point rows would occur can be planted to permanent vegetation if the farmer desires.

There are a few ground rules he will need to follow if he wants terraced fields with the smallest possible number of point rows:

All old terraces, turn rows, headlands, and other surface irregularities should be smoothed down. This is done best with bulldozer or scraper, so the soil can be placed in low spots to even up the field surface.

All swales and draws that are a part of the surface drainage pattern for the field will need to be used as waterways. This may call for more waterways than the farmer is accustomed to, but they are absolutely necessary. Good terrace alinement cannot be obtained if terraces are run across these natural drainage swales. The waterways are easy to cross with present-day power-lift, mounted equipment.

In some fields there are areas of steep, rough, or badly eroded land that must be taken out of cultivation in order to have a good terrace system. These areas can be pointed out by the technician as he runs the lines.

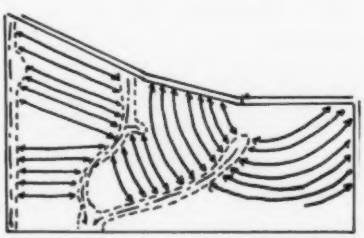
The farmer who is willing to abide by these ground rules is rewarded with terrace systems that are very little more trouble to work with large equipment than an unterraced field would be. In addition, he has the satisfaction of knowing that his fields are protected against erosion.

Georgia farmers are among those who have turned extensively to parallel terracing. On the Carl Bowen farm in Dooly County, for example, the old terraces had been run from field boundary to field boundary, crossing several natural swales. All areas between terraces were irregular in width, and a high percentage of the field area was in point rows. Bowen's old terraces were smoothed down and a new system installed, using the

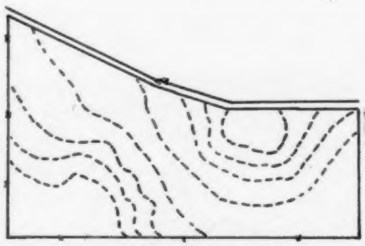
natural swales as vegetated waterways. This layout eliminated all point rows except in three small areas.

Ralph Burton is another Dooly County farmer who had a field of old terraces removed and new ones installed. With the old terrace system, a large part of the field was in point rows. In the new system, most of the terraces are parallel, and there are only two small areas in point rows.

Since the first work of this type in Georgia was done in 1957, approximately 4,000 miles of parallel terraces have been built. Enthusiastic Georgia farmers have acquired several hundred pieces of special equipment to help them install and maintain their improved terrace systems, including land levelers, reversible plows, and large and small scrapers. Equipment companies have held some 40 demonstrations on terracing, land smoothing, and waterway construction.



Old terrace pattern on Carl Bowen field in Dooly County, Ga.



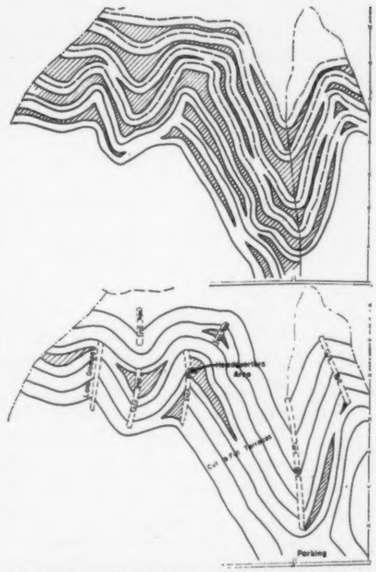
Re-terraced field after old terraces were smoothed down.

Some of the first work on improved terrace alinement was done by Soil Conservation Service technicians in Iowa as early as 1949. Since that time, more than 2,000 miles have been built by Iowa farmers. Part of the work in this State has been on fields with very irregular topography. This has resulted in the need for considerable cutting and filling along the terrace line, to keep the terrace grades within allowable limits that would not cause erosion of the terrace channel.

A system of level terraces was installed on the Eural Anderson farm near Silver City in Mills County, using the cut-and-fill procedure. If the terraces had been constructed in the conventional manner, about 28 percent of his entire field would have been occupied by point rows; whereas the point-row area was reduced to approximately 7 percent of the field area by cutting and filling to get better alinement of the terraces. The same technique for building a system of graded terraces on the Fred Link farm near Farrar eliminated nearly all point rows for him.

Farmers in Alabama have made the greatest progress in adopting the new method of terracing. Since the first such installation in 1952, approximately 12,000 miles have been constructed. Olaff Ivey of Houston County was the first farmer in the State to build parallel terraces. His comments are typical of those voiced by farmers wherever such terrace systems have been installed: "After running my cotton picker on parallel-terraced fields, I feel like I am ruined when I get on fields not having terraces parallel. When you turn the cotton picker around in the field to pick up short rows, you strip off many limbs and bolls and mash down stalks, and the unopened bolls rot."

J. S. Bradshaw of Cottonwood had this to say: "This is the easiest crop I have made since I have been on this farm. I can run out on that waterway and turn around without stopping. My parallel terraces and waterways are not for sale."



(Upper) Shaded areas would be in point rows in old terrace layout. (Lower) Map of same Eural Anderson field in Mills County, Iowa, showing point rows reduced by land smoothing.

And C. B. Crowley of Ashford agreed that "It is easier to operate my machinery on fields where I have parallel terraces. I also save time in planting and harvesting."

South Carolina farmers also are going in for improved terrace alinement. Something like 1,000 miles of the newly designed terraces have been built since 1955—more than 250 miles in the past year alone. Many new peach orchards

The only point rows in Will McSwean's parallel-terraced field near Ozark, Ala., are in left background. Terraces spill into waterways and grassed border strips.

in South Carolina have been planted on fields with newly constructed parallel terraces. In orchard layout, the waterways are made extra wide, so that harvesting equipment can travel along the outer edges without damaging the center position where water will flow. South Carolina farmers also have found that parallel terracing and stripcropping work well together. Farmers in many other States are making worthwhile progress in parallel terracing with the assistance of Soil Conservation Service technicians made available through their soil conservation districts. Not all problems have been solved; but it has been found that terrace alinement can be greatly improved in practically all cases by planning the terrace system to fit the natural drainage pattern of the land, and by following the few "ground rules."

Soil Compaction Reduces Yields

Excess soil compaction cuts crop yields, sometimes as much as 54 percent, as shown by findings in a two-year study of the value of minimum tillage at the University of Minnesota.

Soil surfaces were packed with a heavily loaded truck, and the plow layer with a special weighted wheel. The resulting compaction produced soils with less air space and harder penetrability, much like that which occurs from overuse of field machinery.

In field trials with the experimentally packed soil, potato yields dropped 54 percent. Packing also reduced wheat and sugarbeet yields 13 percent and cut corn yields 7.5 percent.

When both surface soil and plow layer were packed, corn yields dropped 14.5 percent.

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Farm fires caused losses estimated at $165 million during 1960, says the Agricultural Reseach Service.

DAM OVERHAULED By "Arctic" Engineering

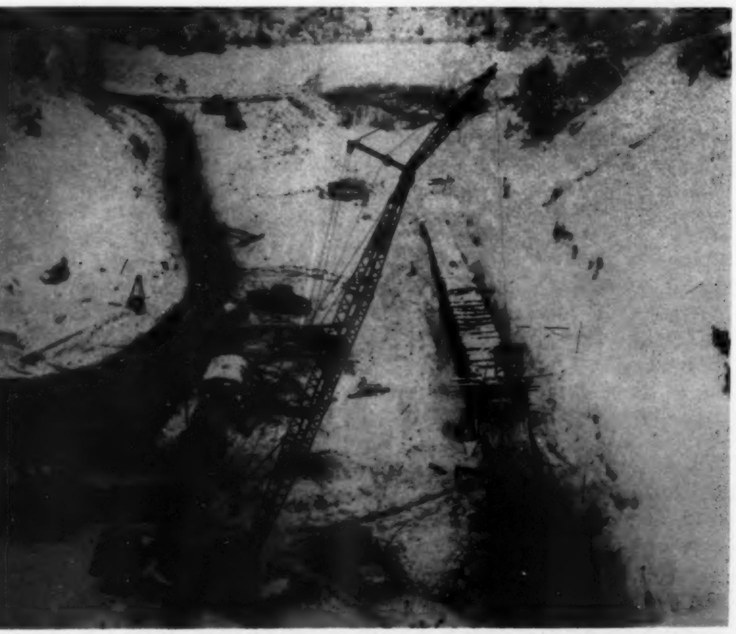
By Harold W. Bradford and Truman G. Spannagel

FARMERS served by the Montezuma Valley Irrigation Company in southwestern Colorado have enjoyed a far more stable supply of water for three years now because they modernized their irrigation system by rehabilitating their more than 50-year-old Narraguinnep Reservoir.

Overhaul of this irrigation old-timer, along with the entire system, was accomplished through the Dolores Soil Conservation District with technical help of the Soil Conservation Service. It was a mid-winter achievement calling for tricks worthy of arctic engineering techniques.

Most of the farming in this part of Colorado, famed for its ancient Mesa Verde cliff dwellings, is at an altitude of between 6,000 and 7,000 feet. The growing season is short, the winters usually are long and cold, and most of the moisture comes in winter snows. Irrigation is vastly important to the area's economy.

Irrigation water for most of the county's feed and grain crops comes from the Dolores River, which rises in the rugged, snow-cowled San Juans to the north and east. It reaches the farmlands by way of the Montezuma Valley Irrigation Company's system of canals and ditches. From the beginning of irrigation in the valley, a more stable flow has been a pressing need. In spring, fast snowmelt has sent torrents downstream. In summer, when crops still needed



Nearly 20 inches of snow failed to halt construction of the Narraguinnep dam. Equipment ready to pour concrete for a conduit section.

water, there nearly always has been a shortage.

The company built Narraguinnep Reservoir in 1907, with 9,250 acre-feet of storage. It also built Totten Reservoir about the same time, but it was unsatisfactory and was abandoned. A reservoir the company built in 1937 on Groundhop Creek 35 miles upstream also was largely a disappointment, because its 21,000 acre-foot capacity rarely has been more than half-filled; but it does serve areas water flow from Narraguinnep can't reach.

Narraguinnep itself gave trouble

The reservoir is nearly full a few weeks after completion of the dam.

Crane ready to make the third pour on well tower for the dam.

almost from the start. There were seeps and occasional sloughing of the upstream surface of the dam. Finally, a big seep developed, and the owners were worried about the dam's safety.

An agreement with the Dolores district outlined all phases of action needed to develop a modern irrigation system furnishing water to approximately 35,000 acres of land owned by 700 farmers, a large percentage of whom have basic conservation farm plans. The measures they are using include land leveling, new irrigation structures, conservation cropping systems, adequate crop-residue use, fertility maintenance, and efficient use of irrigation water.

Studies by Soil Conservation Service men assigned to provide technical help to the district showed that the capacity of the Narraguinnep Reservoir could be increased feasibly by 10,000 acre-feet, or to a 19,000 acre-foot total, despite the fact there were such problems to deal with as layers of porous sandstone and a major fault in the geologic formations. Studies of site conditions by Service geologists and soil scientists supplied the information needed by the engineers in design and construction.

The SCS engineers and the irrigation company agreed that, in order to get the increased capacity, the reservoir level would have to be raised 20 feet. To do this would require three dikes, in addition to the added height of the dam. The engineers decided to relocate the Lone Pine Lateral on the north and northwest shore. Three new drop structures were designed to stabilize the canal grade. This work was done by the company maintenance crew.

The Colorado Highway Department wanted to use the dam as part of a State highway asphalt link, meaning a wider crest on the dam than otherwise would have been needed, at an added cost of $29,362, borne by the highway department.

A contractor with wide experience in high-altitude, wintertime construction went to work in November 1956. He had 120 working days in which to complete the nearly half-a-million-dollar job, before the start of the irrigation season.

The winter began with unusual cold, and heavy snows followed—18 inches in one storm. Because frozen earth could not be used in the embankment, the contractor put on around-the-clock shifts. By using various devices to combat frost and snow, he succeeded in completing the job on June 17, 1957, at a total cost of $495,317, or a cost of roughly $50 an acre-foot to the irrigation company for its added water capacity.

Snow had to be hauled from the embankments after each storm, to prevent any variation from the desired moisture content of the material. Material that became too moist was removed, and dried or mixed with dry material and replaced.

The old conduit tunnel was straightened, enlarged, and extended with reinforced concrete, each section being covered with

Note:—The authors are, respectively, work unit conservationist Cortez, Colo., and engineer, Glenwood Springs, Colo., both of the Soil Conservation Service.

plastic sheets to keep it warm during low-temperature periods.

Finally, sand-and-gravel embankment "blankets" were riprapped with rock.

With the other improvements they have been making as cooperators with their soil conservation district, Montezuma Valley farmers are obtaining profitable returns from more efficient farming operations, through the conservation use of both their soil and their water resources.

Fallout Shelters For Farm Animals

How can a farmer protect his animals from radioactive contamination in case of nuclear attack? Henry B. Thompson, test officer for the Maryland Civil Defense Agency, says animals can survive as well as farmers if adequate precautions are taken.

A special shelter for animals is a good idea, he says. Several feet of hay in an overhead loft or stacked around the sides of a barn would offer protection. So would a barn basement, particularly if earth fill is placed against the exposed wall. One farmer, Thompson notes, has built a shelter around a well—a better source of water than a stream, pond, or lake in case of fallout.

Some animals, notably donkeys, horses, and hogs, resist fallout as well as humans and better than other animals. Poultry survives very well.

Milk from cows exposed to radiation can be used safely if the cow has not taken contaminated food or water, Thompson says. Even contaminated milk can be saved, by converting it into butter and cheese and storing the products until the radioactivity has diminished.

The risk of serious contamination in eggs is relatively small, and would have to be accepted when there was a shortage of food. In cases of doubt, the eggs should be preserved and stored.

Geologic Studies Pay Off In Conservation

By A. F. Geiger

BASIC geologic investigations are paying their way many times over in soil and water conservation structural and related developments over the country.

Those benefiting include individual landowners, irrigation and other groups, and communities and governments in small-watershed protection and flood prevention projects. These projects, with their dams and other works, have stepped up the need for such investigations sharply in the last few years.

In the comprehensive program of soil and water conservation for which the Soil Conservation Service provides technical aid, its geologists are primarily concerned with three phases of geology. One is engineering geology, the study and subsurface exploration of foundations for structures. Another is sedimentation, or the study of erosion and erosional processes, and entrainment, transportation, and deposition of sediment. The main concern here is the acceleration of these processes which has resulted from man's activities. The third is groundwater geology, or the study of the movement of water underground and its availability for use.

There are many examples of how geologic studies have resulted in significant savings. Take, for instance, one of the Public Law 566 watershed projects in western Minnesota:

During planning, geologic investigations of a proposed damsite revealed poor subsurface conditions. Remedial measures necessary to make it a safe site would have cost an estimated $132,000. Further investigations, however, disclosed another site about half a mile downstream with much better subsurface conditions. Some remedial measures still were necessary, but it was found that they could be completed at an estimated cost of only $32,000. This difference represented a direct savings of $100,000 in eventual construction costs in return for the expenditure of but a few hundred dollars for geologic investigations.

Such studies helped assure a good irrigation well on the ranch of R. D. Hadley near Carlin, Nev., in the Humboldt River Soil Conservation District. His ranch is in an area where quite a number of dry holes and poor wells have been drilled. At Hadley's request, SCS geologists explored the surface geology of the area. This study indicated that the alluvial deposits of Maggie Creek and the underlying lava should be well supplied with water by seepage from intermittent flows in the creek. The problem then became one of locating an area where the alluvium was permeable enough and extensive enough, or where the lava flows were cracked and fractured enough, to yield large quantities of water.

To this end, four small-diameter test holes were drilled and logged. After the logs were studied, it was recommended that the large-diameter irrigation well be drilled near the test hole showing the thickest section of permeable materials. The completed well produces 1,330 gallons a minute, or enough good-quality water to irrigate 130 acres.

Note:—The author is geologist, Soil Conservation Service, Beltsville, Md.

This acreage produces enough feed for Hadley's breeding herd of cows, the core of his livestock business.

"During the three years this well has pumped," Hadley said, "I have raised 600 tons of hay I wouldn't have had otherwise, worth at least $15,000. In addition, I have harvested approximately 750 animal unit months of aftermath worth approximately $3,750. This gives a gross return of $18,750 for the three years. To me this is an excellent return on my investment."

During the devlopment of the watershed work plan for Camp Rice Arroyo near El Paso, Tex., studies of sediment in the stream channel and of the stream gradient below the proposed floodwater-retarding structure indicated that serious erosion would occur. Sediment deposition would cause severe damage to road and railroad facilities and to valuable cropland, and erosion possibly would endanger the structure itself. A grade-stabilization structure was placed in the channel below the floodwater-retarding structure and is providing protection against these damages.

In 1957, the Stemilt Irrigation District at Wenatchee, Wash., needed more irrigation water, because of high leakage losses from existing reservoirs, and proposed to build a new dam on Stemilt Creek. After a preliminary investigation of the proposed site, the SCS geologist recommended core drilling to explore the foundation further. The detailed exporation revealed foundation conditions which made impossible the construction of an economically feasible dam. As no other damsites were available, it was recommended that two existing dams be investigated to see if it would be feasible to repair and possibly raise them.

The leakage areas of these reservoirs were located, and the recommended measures reduced the leakage from one reservoir by 90 percent and from the other by 70 to 80 percent. Further repair will cut down the leakage in the latter reservoir even more. The geologic investigations and repair work cost between $30,000 and $40,000 less than the proposed new reservoir would have cost, and more water is being stored by the repaired reservoirs than the proposed reservoir would have been able to store.

Drilling the Hadley well.

The city of San Antonio, Tex., and the farms in the vicinity obtain their water from the underground water reservoir of the Edwards limestone plateau. The water supply in the reservoir is being depleted at an alarming rate, and severe water shortages are predictable within the next 20 or 30 years unless something is done. Geologic investigations in the Salado Creek watershed, just north of the city, have revealed an extensive area where the limestone is broken by a series of faults and cracks. This is an area where water from the surface has easy access to the underground reservoir. However, much of the surface runoff in this area comes in the form of flash floods, which carry most of the water past the fault zone before it has a chance to filter down to the aquifers.

The well in operation.

The watershed is being planned as a flood prevention and watershed protection project. Some of the proposed floodwater-retarding reservoirs are to be built so they will back water over the fault zone, where it can flow directly into the aquifer. Several others will be built above the fault zone so that floodwater, being released slowly from the reservoirs, will have a better chance to infiltrate as it passes the fault zone.

In this way, an additional 3,490 acre-feet of water will be put into the ground each year. This water has a value of about $14 an acre-foot. About 40 percent of the additional water will be used by the city of San Antonio, and the rest will be available for irrigation and stock water.

Highly valuable agricultural land in the Calleguas Creek watershed in Ventura County, Calif., has suffered severe damage from deposition of infertile sediment from the creek. Geologic investigations determined that the source of 80 percent of the sediment was channel scour and bank erosion on the main channel of Calleguas Creek above the damage area. The remaining 20 percent came from gully and sheet erosion in the upper watershed. The eroding portion of the channel was treated by putting in a series of concrete stabilizers, which control the grade of the channel and keep water velocities down to a non-eroding rate. As a result, the sediment problem has essentially been alleviated.

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Census figures show that from 1950 to 1960 there were a total of 1,291,000 farms in the U. S. that produced over $5,000 gross sales in farm produce.

Grassed Waterways Boon to Kansas Farm

By George R. Smith and Grant Woodward

EUGENE O'Trimble thinks his grassed waterways give him more return acre for acre than any other land on the farm. And with good reason, because he and his sons have been producing from 100 to 125 bales of hay to the acre, plus about 500 pounds of bromegrass seed, a year.

This high return from his waterways doesn't take into account ridding his fields of the land-chewing, unsightly gullies that they have replaced, nor does it include the abundance of good water which now serves a farmstead that too often was without enough water before.

The O'Trimble farm setup is a beef-wheat-corn-milo-bromegrass operation in the Jefferson County Soil Conservation District in northeastern Kansas. O'Trimble, a member of the district board of supervisors, grew up on the place. The layout of his boyhood has been expanded until the O'Trimbles now own 1,100 acres of productive, conservation-treated farm and pasture land. One of his sons, Eugene, Jr., and his family live on part of the farm; and a second son, Robert, also takes part in the farming operations.

The O'Trimbles added the newest 160-acre piece to the farm only 3 years ago. It was real problem land. Numerous gullies were gnawing up the slope toward the farm buildings. Two major gullies had nearly reached the property lines, making the fields virtually inaccessible to farming equipment; and the fields had grown up to weeds and elms, with a scattering of lespedeza. Referring to the sad condition that the farm had been in, veteran conservation farmer O'Trimble said:

"It's a shame that everyone doesn't use good conservation farming practices. These two larger gullies had been allowed to grow until they were 10 to 12 feet deep. They were full of brush and timber. It was a rough-looking mess."

His formula for taking care of such gullied land boils down to this: "Get a contractor who has the right machinery and who knows his business. Get the Soil Conservation Service boys to plan and stake out the job, and keep an eye on things as they progress." Eugene and his sons do the smaller construction jobs themselves, but the larger jobs are contracted out to local soil conservation contractors.

Controlling the big gullies called for two large waterways and an erosion-control dam. The waterways were designed by Soil Conservation Service engineers to carry the estimated peak runoff from a 10-year-frequency storm at a velocity of 2 cubic feet per second. Broad, gently sloping, easy-to-cross waterways, accurately engineered to dispose of excess water without harm to the land, replaced the steep-sided, V-shaped gullies that had made the farm unprofitable for cultivation.

The dam is a 5,400-yard earth fill, with a 24-inch pipe to drop overtopping water to the stable natural channel below the dam. The pipe spillway was designed to carry a 5-year-frequency storm runoff, taking into account demands which might be placed upon the structure by rainstorms of a 25-year frequency. Permanent sod protection for an emergency spillway is a built-in feature.

O'Trimble, Sr., admires bromegrass-covered waterway, once a deep gully, in April after record March rainfall failed to damage it.

Note:—The authors are, respectively, State engineer, Salina, Kans., and agricultural engineer, Lincoln, Nebr., both of the Soil Conservation Service.

The O'Trimbles of Williamson, Kans., left to right: Robert, Eugene, Jr., and Eugene, Sr.

From the dam, water is pumped through a settling tank, a filtering tank, a chlorinator, and a water softener to the faucets serving the younger O'Trimble family. Although this added dividend was not foreseen when the gully-control work began, there now is a dependable supply of good-quality water from the reservoir created by the erosion-control dam. The flow from a small spring keeps the water level comparatively stable, within a foot or two of the drawdown pipe. The well at the farmhouse used to supply only about two bucketsful of water and then stop. Terracing, the grassed waterways, and contour cultivation on the O'Trimble land combine in this and other ways to give the operator efficient use of the moisture that comes in rain and snow.

O'Trimble has some practical advice on how to keep shaped waterways from becoming gullies again: "Don't skimp any place on this job. A waterway with a gully down the middle puts you right back where you started. Shape a gully in the early fall. In this country, plant bromegrass—we broadcast it. Overseed it lightly with wheat for a nurse crop. Then use enough fertilizer for the job."

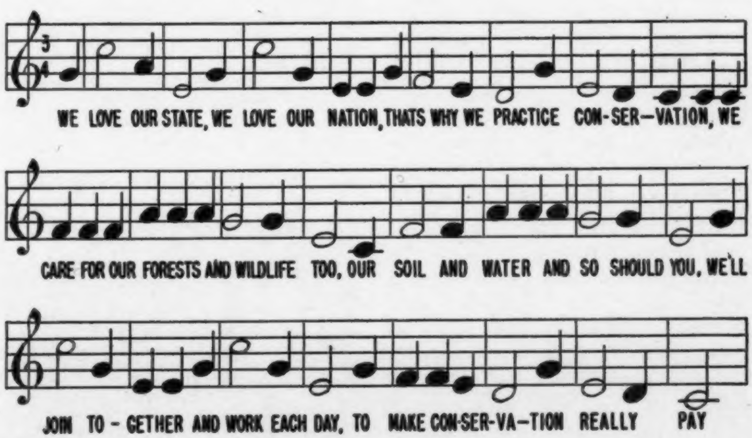
He uses about 100 pounds of nitrogen a year on his waterways. "Bromegrass, like corn, will stand about all the fertilizing you give it," O'Trimble has found. "Give this grass here another year and nothing will hurt it."

All natural drains on the O'Trimble place have been shaped into waterways. This system has made possible the use of shorter terrace lines, better terrace alinement, and greater convenience in farming operations. The drains are highly productive of hay, grass, and forage when used as grassed waterways, because of the fertility of the soil and the added moisture they retain. Untreated, these same natural drains would have continued to be a hazard as raw gullies, being a source of sediment from erosion, adding to the difficulty of farming operations, and providing a source of concentration of weeds and other unwanted growth.

The grassed waterways are not the only measure that makes O'Trimble sure that soil conservation pays. For example, the red clover he uses to build up his land also furnishes hay for livestock, and the past two years he has netted $40 to $50 an acre from seed. He also figures that the soil and water conservation program on the newly acquired 160-acre tract has added several thousand dollars to its value.

"Besides," O'Trimble says, "the money value isn't everything. It's worth a lot just to stand and look at, the way it is now. Grassed waterways are a lot more attractive than raw gullies."

OUR CONSERVATION SONG



SCHOOLCHILDREN in South Carolina now are learning about conservation with the aid of a song. It was written and set to music by Mrs. Theo P. Hartin, principal of the Arden and John P. Thomas elementary schools in Columbia, S. C.

Mrs. Hartin has taught conservation of soil, water, woodlands, and wildlife to elementary school children for a number of years, and has helped with a conservation workshop at the University of South Carolina for several years. She also is a member of the South Carolina Advisory Council on Conservation Education.

In 1957, Mrs, Hartin was presented the "Woodmen of the World Conservation Award" for her work in teaching conservation of natural resources to children. She says, "I have proved to myself that conservation of natural resources education can be correlated with subjects taught in elementary grades."

Watershed Structures Call For

Major Engineering Planning

By Eugene C. Buie and Carroll A. Reese

MADISON County's South River watershed in Georgia provides a typical example of the problems which soil and water conservation engineers and their fellow technicians come up against throughout the Southeast and the rest of the country in planning flood-prevention dams and other water-management structures in creek-size watersheds.

These structural works of improvement, in nearly all watershed protection and flood prevention projects, are essential in complementing conservation land use measures applied by landowners on watershed fields, pastures, and woodlands. All of these measures together call for the combined efforts of conservation engineers, soil scientists, agronomists, range conservationists, plant materials specialists, woodland conservationists, biologists, and others, as local situations may dictate.

The Broad River Soil Conservation District and Madison County officials in May 1955 applied to the Secretary of Agriculture for Federal technical and financial help in developing a small-watershed project as provided in the Watershed Protection and Flood Prevention Act. Immediately after the State Soil Conservation Committee assigned the watershed priority for planning early in 1960, a preliminary investigation was made by the Soil Conservation Service,

SCS Design Engineer Hal Pridgeon completing floodwater-retarding structure design.

which has the responsibility of carrying out the Department of Agriculture's assistance in watershed projects.

This investigation was to determine whether the project was feasible. It was necessary to find out whether the flooding and other problems could be solved by watershed treatment within the scope of the Act, and whether the benefits to the landowners and the sponsoring local community would be enough greater than the cost of the project improvements to justify going ahead.

The South River project's experience also illustrates how careful, step-by-step investigation and sound planning develop progressively more accurate and dependable information on which to base

Principal spillway of floodwater-retarding structure under construction.

Note:—The authors are, respectively, watershed planning specialist and design and construction engineer, Soil Conservation Service, Spartanburg, S. C.

inal project development. For example:

In making the preliminary investigation, 51 potential floodwater-retarding structure sites were considered. The planning engineer determined that existing stream channels would have to be enlarged. The engineer, the economist, and the hydrologist, working as a team, identified the damage areas and charted a structural program designed to reduce damage and provide an agreed-to level of protection to the damage areas. The watershed was authorized for planning in June 1960, and surveys were started immediately.

Cross sections were surveyed across the flood plain at locations selected jointly by the hydrologist and the economist. Surveys of selected floodwater-retarding structures and the stream channels were made, to provide data for preliminary design and for cost estimates. Surveys to determine storage capacity of each of the floodwater-retarding structures were made in the detail necessary for use in final structure design. Further consideration of the 51 potential sites indicated that many of them would not be suitable.

The local people had advised the planning party of the minimum reduction in flooding which would be acceptable to them, and they and the watershed planning party had agreed on the project objectives. With these objectives in mind, the engineer, hydrologist, geologist, economist, and planning party leader selected the floodwater-retarding structure sites which, along with channel improvement, appeared most likely to provide the protection desired.

A floodwater-retarding structure nears completion.

The hydrologist analyzed the effect of these structures on the depth and area of flooding to be expected from storms in the historical flood series. He advised the engineer of the size channels required to reduce flooding enough to meet project objectives. After the engineer designed these channels, an analysis of the expected reduction in flooding was completed.

The economist completed the evaluation of expected benefits, which were compared to the estimated costs and to project objectives. The results then were discussed with the local people. Adjustments, including the substitution of alternate sites and re-evaluations, were made where necessary. The upshot was that the local people and the planning party agreed to a proposed project consisting of 8 floodwater-retarding structures that will be the most effective and beneficial, and approximately 100,000 feet of channel improvement.

After any watershed work plan is approved for installation of works of improvement, the local people must obtain the necessary easements and rights-of-way for each structural measure. As soon as these are available, the State conservation engineer begins the surveys to gather the necessary data for the final design of the measures. The final design of the structures also depends on surface and sub-surface investigations, soil samples, and physical features. When these investigations and studies are completed, the dam is

A typical watershed-project channel before improvement.

The channel after clearing and snagging was completed.

ready for the final design. The construction and material specifications then are prepared.

Channel improvement may consist of clearing and snagging of the existing channel, enlarging it, or excavating a new channel. The type of any improvement included in a watershed work plan is based on the degree of protection desired and its economic justification. The method and intensity of field surveys vary with the type of improvement. Where new channel construction is planned, borings to determine what materials may be encountered usually are made with a power auger along the proposed centerline of the channel.

Actual construction is the test of the value of the design and plans, and must be of high quality. Because Federal money is involved, when a construction contract is awarded, a Government engineer is assigned to the job, with the responsibility to inspect all materials and determine that the construction complies with the plans and specifications. In addition to standing its share of project development costs, the local sponsoring organization is responsible for maintenance of the completed improvements. Any successful watershed project is the result of such cooperative effort of the local people and of the technical specialists and all others concerned.

NEW WATER MANAGEMENT SYSTEM Helps Louisiana Sugarcane Growers

By Larkin B. Agnew

A GROWING number of progressive Louisiana sugarcane farmers are taking a second look at combined land grading and new V-type ditches as a means to better and more economical water management in their fields.

The old surface drainage pattern, that has remained unchanged since Jesuit priests established it when they introduced sugarcane into Louisiana more than 200 years ago, consists of lateral, or "split," ditches running down the slope of the land. They usually are 100 to 250 feet apart, with top widths of 3 to 4 feet, depths of 1.5 to 3 feet, and bottom widths of 1.5 to 2 feet. They drain into larger cross-ditches and thence into an outlet canal, bayou, or swamp.

Type of earthmoving equipment contractors generally use for "rough" land grading.

Quarter drains carry water from the sugarcane rows to the split ditches. In contrast to the new-type ditches, these quarter drain ditches, excavated across the cane rows just deep enough to give drainage to the row middles, must be opened again after every cultivation; and the split ditches themselves require maintenance every few years. The split-ditch system was not a particular problem as long as cultivation was done with mules and an adequate supply of cheap hand labor was available, but farm mechanization increased the maintenance problems. Machines have been developed for cleaning out these ditches, but at considerable expense; and a large amount of weed control in the split ditches, and maintenance of quarter drains, still is done by scarce and costly hand labor.

Intensive study was given the problem of devising an improved drainage pattern, by the Agricultural Research Service and Soil Conservation Service engineers. The need was to reduce the number and the linear feet of ditches to the acre, and to design another type of ditch. It was decided that a field be land graded on a trial basis, with V-type ditches installed which could be maintained and crossed with existing farm equipment.

The kind of split ditches eliminated by land grading.

Owner Frank H. Carruth, Jr., and Manager John C. Best of the Margaret Plantation made available a 30-acre trial plot on their farm in the Upper Delta Soil Conservation District in West Baton

Note:—The author is area engineer, Soil Conservation Service, Alexandria, La.

Rouge Parish. It was a joint project of the Soil and Water Conservation Research Division of ARS, the Louisiana Agricultural Experiment Station, and the SCS. The design layout and grading were done during the summer of 1956. The research men have made careful evaluation studies each year since, and found the results encouraging enough that the practice of land grading on sugarcane land has begun to spread.

Land grading for drainage simply means shaping the land surface to planned grades determined from a grid survey. In addition to reducing the number and length of the ditches and reducing maintenance costs, low, wet areas that tend to drown out the sugarcane are eliminated. These wet spots may be natural, or they may have resulted from failure to dispose of spoil dirt from the split ditches properly, or from the method of plowing. With the elimination of the low, wet areas, more efficient production can be expected.

It has been found that land to be graded should be taken out of crops for one year, in order that the grading can be done in the summer and fall months in favorable weather. A grid survey is required, to determine planned grades, cuts and fills, and cubic yards of earth to be moved. Before the design survey is made and construction begins, fields should be free of vegetation, and they should be plowed and smoothed. It is preferable that a rain settle the ground before the survey is begun.

During the land grading, some split ditches are eliminated, the number depending upon their spacing and the size of fields economical to grade as single units. Ditches parallel to the row direction which must remain are changed to V-type lateral ditches with slopes flat enough to be maintained by mowing or with a motor grader.

Surface field ditches are built across the rows to convey row water to the V-type laterals. These surface field ditches replace the old quarter drains. Normally, 1 surface field ditch will replace 2 to 5 quarter drains. In this way, an additional 5 to 10 percent of usable farm land can be acquired by land grading.

Sugarcane on Frank Carruth, Jr.'s land-shaped and graded field in the Upper Delta SCD.

The surface field ditches are shallow, V-type ditches with slopes flat enough for cultivating and harvesting equipment to cross. Because of frequent crossing and absence of vegetation, they need cleaning out more often than the V-type laterals.

Surface field ditches determine the number of V-type laterals needed in a graded field. Field ditches should be limited in length to drainage of 600 to 800 feet in one direction; but where a field ditch drains in both directions, V-type laterals can be as much as 1,200 to 1,600 feet apart.

Many types of earthmoving equipment are used in the grading job, including large scrapers pulled by track-type tractors and smaller scrapers pulled by wheel tractors. The first type ordinarily is used by contractors and the latter by farmers using their own equipment. After the field is cut to the planned grade, a land plane is used to smooth the field. Three hundred to four hundred cubic yards of dirt are moved per acre, on the average, at a "turnkey job" cost of 25 to 30 cents per cubic yard.

Farmers in the Upper Delta district, which includes both the West Baton Rouge and Pointe Coupee parishes, have completed land grading on approximately 200 acres. Cooperators Ben C. Duvall, who has graded 20 acres, and M. J. Kahao, who has graded 50 acres, reflect the reaction of local landowners to the new water management system. Both stated they thought the yield resulting from the improved water management on their sugarcane land would pay for the cost of the precision land grading in 4 to 5 years.

No accurate figures are yet available generally on increase in yields as a result of land grading and V-type ditching. But all the farmers who have done this type of work have indicated they are well pleased with its reduced maintenance costs and other benefits.

The St. Anthony Falls Hydraulic Laboratory

By Fred W. Blaisdell

NUMEROUS improvements of existing designs for hydraulic structures and many new types of structures for the conservation and control of soil and water have been developed at the St. Anthony Falls Hydraulic Laboratory. The Laboratory is located at the University of Minnesota, where the Laboratory, the Minnesota Agricultural Experiment Station, and the Agricultural Research Service cooperate to solve problems for the Soil Conservation Service.

The hood inlet for pipe spillways, now used so frequently for farm ponds, was developed at this laboratory. Previously a drop-inlet spillway was the only structure available to carry the frequent small flows that drown and destroy the lining of vegetated emergency spillways.

Researchers at Oregon State College had found a way to increase the flow capacity of highway culverts by extending the roof over the entrance apron. ARS engineers at the St. Anthony Falls laboratory and an SCS engineer, M. M. Culp, saw the tremendous potentialities of the Oregon inlet. They cut a pipe on an angle of 37° and laid it with the long side on top, then placed a shield over it to form a hood over the pipe entrance. The resultant hood inlet is an old story now. Developed solely with SCS use in mind, this inlet now is being adopted by highway engineers as a culvert entrance.

The ARS research at the St. Anthony Falls laboratory was begun in 1940 at the request of the SCS because scour had undermined the outlet end of many of the drop-inlet spillways then in use. This scour was endangering many structures. Research was needed to protect existing structures and to design new structures.

The initial work on outlets led to the development of the St. Anthony Falls stilling basin for use at the exit of culverts, chutes, and dams. The SAF stilling basin has chute blocks at the entrance of the basin to break the entering stream into a number of jets, floor blocks to create turbulence that will use up the destructive energy of the flow before it is discharged into the stream channel, and an end sill to direct the bottom currents upward away from the streambed and thus prevent scour damage to the bed.

Although the SAF stilling basin is used for some of the smaller structures where the soil is very erodible, it is used primarily for flood prevention dams built by SCS. The first non-experimental SAF stilling basin was built by SCS in Crawford County, Iowa. It has since been used extensively by other Federal and State agencies, both in the United States and in foreign countries.

The facilities of the St. Anthony Falls Hydraulic Laboratory are

The St. Anthony Falls Hydraulic Laboratory and surrounding area.

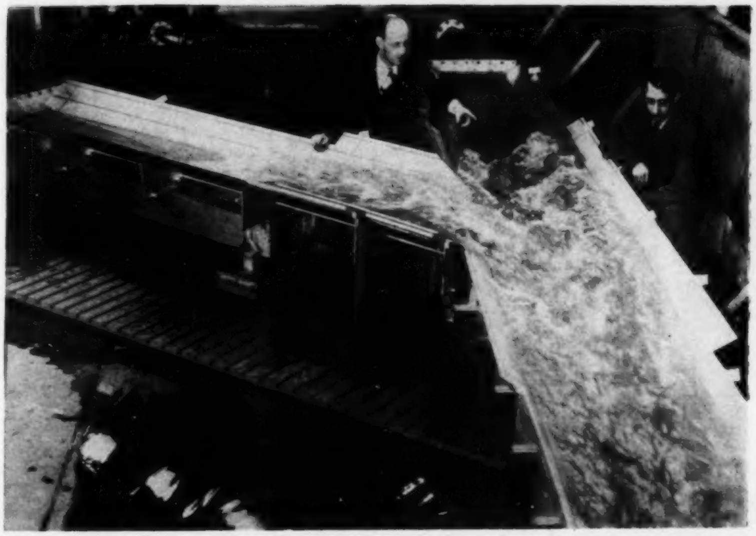
Note:—The author is hydraulic engineer, Agricultural Research Service, Minneapolis, Minn.

well adapted to the type of research being conducted there. The laboratory is located on Hennepin Island at the St. Anthony Falls in the heart of Minneapolis. The Mississippi River has a fall of 50 feet at the laboratory site, and this entire fall is available for laboratory experiments. Water for most of the experiments is diverted from the Mississippi River above the falls and is returned to the river below the falls.

The Minnesota State Legislature granted the University of Minnesota and the Laboratory the right to draw three millpower—the water required to operate three flour mills—continuously from the river at any time. This amounts to about 40 cubic feet per second; but the Laboratory is designed to use 300 cubic feet per second when this amount of water is available and is needed.

The laboratory building is six stories high. Built into the falls as it is, four of the stories are below the upstream level of the river. As a result, gravity flow of water is available throughout most of the laboratory. The upper levels are used for offices.

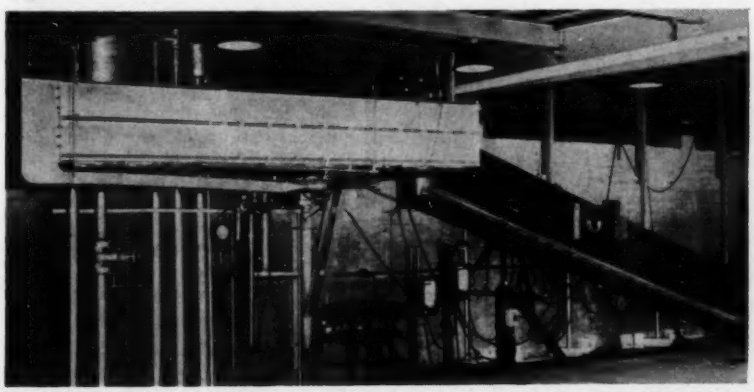
An unique feature of the physical plant is a pair of large volumetric tanks located outside the laboratory. Water from many of the experiments can be diverted into these tanks and measured continuously with an accuracy of better



Flow conditions at junction of concrete lined ditches on Whiting Field Naval Air Station are simulated for testing at the St. Anthony Falls Laboratory.

than one-fourth of one percent. Similar tanks on scales are located inside the laboratory and are available for measuring flows up to about 10 cubic feet per second. When especially precise work is necessary, the means are available to accomplish it!

The opportunity to consult with other experts when special problems arise contributes much to the efficiency of laboratory operations. A staff of specialists in erosion, sediment transportation, pipe hydraulics, hydraulic machinery, theoretical hydraulics, model operation, etc., is always available for



Apparatus used for testing pipe spillways at St. Anthony Falls laboratory.

consultation at the St. Anthony Falls laboratory, an asset equal to the excellent physical plant. Technicians and skilled mechanical help are also available to the ARS researchers as they are needed.

One of the research jobs recently completed was a study of the hydraulic energy losses at junctions of agricultural drain tile.

Formerly it was thought necessary to join a lateral drain line to the main line at a flat angle in order to reduce the loss of energy caused by the junction. This flat junction angle frequently required a hand-fitted curve in the lateral near the junction. Chipping the tile to form the curve and the hand digging required to shape the ditch were time consuming and expensive. The research on the hydraulics of agricultural drain tile junctions shows that all this handwork is unnecessary. The results obtained indicate that the best angle to use to join a lateral to a main is the most convenient angle, whether it be 30°, 45°, or 90°.

Another interesting study at the laboratory was the development of a new outlet for a straight drop spillway where scour endangers the outlet. During the course of the

Earthen dam, box culvert, chute, and SAF stilling basin for a floodwater retarding structure that has a county road crossing the dam in Ventura County, Calif.

study, it was discovered that tailwater levels higher than normal cause excessive scour downstream from the stilling basin. This was a surprising finding, because it was contrary to the widely accepted idea that less scour occurred when the tailwater level was high. Research discovered the "why" of this unexpected phenomenon and developed design rules that prevent the occurrence of damaging scour in field structures. Experience with this new straight drop spillway stilling basin in the erodible sandy soils of northern Florida has verified the efficiency and satisfactory performance predicted by the laboratory models.

No. 63

This is the sixty-third of a series of articles to appear from time to time in explanation of the various phases of research being conducted by the Department of Agriculture on problems of soil and water conservation.

Twenty years ago, when the ARS group first started work on drop-inlet spillways, the hydraulics of closed conduit (pipe) spillways was not understood. The pipe spillway is a simple structure, but its hydraulic performance is very complicated.

ARS research developed a theory of the hydraulics of closed-conduit spillways. The theoretical studies have shown how the laws of hydraulics are applied to the design of closed-conduit spillways, both in the laboratory and in the field.

Model studies conducted on a large number of shapes of drop inlets have developed many useful design criteria. The model studies have also shown how the spillway will perform and have helped answer such questions as: Will the barrel flow full, as it should for maximum efficiency? Will the head-discharge curve show a single value for each head, or will several values of discharge occur at certain heads to make impossible the determination of the flow at any instant?

These and other questions must be answered satisfactorily before a particular form of closed-conduit spillway can be recommended for use by the SCS in connection with farm ponds or flood detention reservoirs. The laboratory work must be done carefully, because a single recommendation affects hundreds of field structures.

A two-way drop inlet with a flat anti-vortex plate is now receiving ARS attention at the St. Anthony Falls laboratory. Information on this type of structure is given highest priority by the SCS, because it is being used extensively in connection with watershed protection and flood prevention activities.

Occasionally, model studies of specific streams or structures are undertaken. A good example was the design of the drainage system at a Naval Auxiliary Air Station at Milton, Fla. The resultant soil conservation structures prevented the destruction of an airfield worth many millions of dollars.

Problems encountered and solved by the use of model structures include entrances for concrete-lined ditches, high-velocity ditch exit structures, the joining together of streams flowing at high velocities, the joining of low-velocity streams to high-velocity streams, and grade-control structures for earth ditches.

An idea of the necessity of model studies can be obtained from a single illustration. At one junction of a high-velocity stream with a low-velocity terrace outlet channel, the model studies showed that waves would overtop the original channel sidewalls by four feet. A new junction design was developed to insure that the flow could be contained within the channel walls.

These are a few of the ways in which the Agricultural Research Service hydraulic engineers at the St. Anthony Falls Hydraulic Laboratory in Minneapolis are helping to solve some of the problems confronting the Soil Conservation Service.

Terrace Club Gets Results

By Martin Max Hawk

THE Grundy County Terrace Club is believed to be the first of its kind in the United States. Organized in 1950 by 21 farmers cooperating with the Grundy Soil Conservation District in northeastern Iowa, it has continued to grow in membership and effectiveness during the ensuing decade. Terracing, for example, has doubled as a result of the club's activities.

To be eligible for membership, a farmer must have terraces on his farm. The farmers attending the first meeting were presented special charter-membership plaques by the district. Members enrolled since have been given framed membership certificates by the club.

"The terrace club has helped me by my association with other conservation farmers who are coping with the same problems I have encountered in building and farming terraces," says Gordon Davidson, an outstanding conservation farmer and first president of the club. "The gain over the years far outweighs the difficulties. We should use all the aids available to make the installation and farming of terraces easier."

Willard Dielschneider, another club member and district cooperator, says: "The club gives us a chance to talk over terrace problems with others who have the same difficulties. It gives us a chance to compare notes, so to speak."

Assisting Soil Conservation Service engineers and other technicians are enthusiastic about the terrace club, because it promotes conservation and helps get more terraces on the land. As area conservationist J. Ross Oliver points out, "The club has added something which sets a terrace farmer apart, because each member feels he is a veteran in a very special way. Farmers just starting a conservation program come as guests to the club meetings; they leave with a strong desire to be part of the club."

The terrace club, which elects officers each year, is self supporting through contributions from members, profits from dinners, and other sources. It finances the purchase of membership certificates, and awards for such conservation activities as speech contests, essay contests, and school conservation projects. It sponsors terrace demonstrations, terrace-building contests, and other activities for the promotion of the terrace program in the district.

The club's big event is its annual banquet. Each member brings his wife, and at least one prospective member and wife, as guests. There is a well-rounded program, highlighted by a discussion panel of at least two club members, a soil conservation district commissioner, and a Soil Conservation Service representative. Through this panel, members and guests present problems for discussion. Speakers have included the governor of Iowa and members of the Iowa State University staff.

Terrace club members practice what they preach. Take Byron Johnson, for example.

"By terracing and keeping the fertilizer on the hill where it belongs," he says, "I harvested 3,000 more bushels of corn from 74 acres than was ever harvested before, and I have the records to prove it."

Dubious at first, Johnson was persuaded by club members to terrace his farm.

SCS technicians believe the terrace club has increased the application of terraces on the land in the Grundy district by at least 100 percent, including the new cut-and-fill parallel terraces.

First Terrace Club officers, left to right (front row): Pres. Gordon Davidson, Grundy Center; Dist. Commissr. James F. Petersen, Dike; (back row) Secy. Lester Rittgers, Cedar Falls; Dist. Commissr. Ralph Schildroth, Reinbeck; Dist. Commissr. W. R. Mitchell, Grundy Center; Vice Pres. Luther Brindle, Whitten.

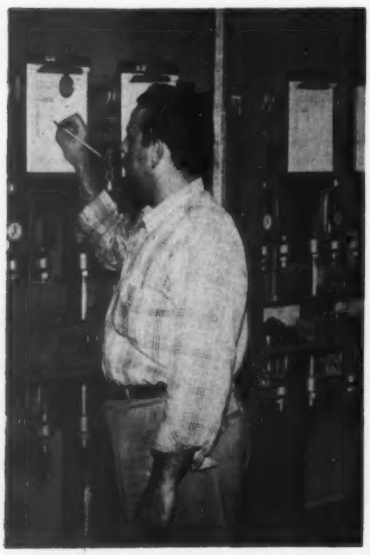
Note:—The author is work unit conservationist, Soil Conservation Service, Grundy Center, Iowa.

Soil Mechanics In Soil and Water Conservation

By Rey S. Decker

The fact that soil as a prime construction or foundation material is used in more soil and water conservation engineering projects than is any other building material means that soil-mechanics tests and analyses are needed in developing most such projects.

For engineering purposes, soil may consist of any mixture of particles ranging in size from the finest clay to cobbles and boulders. A natural soil deposit may be used in place as support for a structure, or it may be excavated, reworked, and compacted into an earth dam. Variable factors such as those related to composition, depth, geologic origin, and the history and proposed use of soils all affect their behavior characteristics.



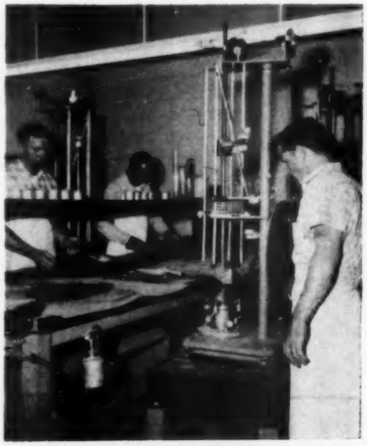
Consolidation apparatus for finding soil compressibility.

To be used by design and construction engineers, these characteristics must be interpreted in terms of specific values of strength, compressibility, water conduction, bearing capacity, compactibility, and related physical and structural properties. The soil-mechanics and soil-engineering investigations and analyses, dating from about 1925, provide the data necessary to predict how a given mass of soil beneath or in a structure will react under different conditions and functional requirements.

The engineering properties of soils must be evaluated for the safe, yet economical, design of such projects as earth dams, concrete or masonry dams founded on soil, irrigation and drainage canals, flood-control levees and dikes, stream-channel rehabilitation, and sealing leaky reservoirs and ponds.

Soil also is the most variable material involved in the engineering projects. The composition and properties of soils often change with depth and within small areas, because of their varied formation and geologic origin. All have different physical characteristics and engineering properties; but for most projects the soil must be used as it occurs on a given site, and the evaluation of its properties and the determination of adequate design values are difficult and complex.

Site investigations for preliminary evaluation of soil characteristics and collection of samples are made by Soil Conservation Service field geologists and engineers. Undisturbed core samples of foundation materials, bag samples of



Compaction test by machine method.

material to be excavated or used for construction, and all pertinent data are sent for testing and evaluation to the Service's Soil Mechanics Laboratory at Lincoln, Nebr., or to testing sections in Portland, Oreg., Fort Worth, Tex., and Spartanburg, S. C.

Standard index and classification tests are run on most samples. These tests include particle-size distribution by sieve and hydrometer analyses and Atterberg limit tests. These tests form the basis for classifying soils by the Unified Soil Classification System. Other index tests on selected samples include specific gravity, soluble salt content, and dispersion ratio. Unit weight and moisture determinations are made on all undisturbed samples. The index tests provide a basis for general characterization of variations in materials and properties of all the samples, and

Note:—The author is head, Soil Mechanics Laboratory, Soil Conservation Service, Lincoln, Nebr.

for correlating field classification and geologic descriptions.

Moisture-density or compaction tests are performed on materials to be placed in embankments and backfills, to provide a soil-density standard for additional tests and for construction control.

Complex tests are run on selected samples to determine specific engineering values which are considered necessary for the solution of design or construction problems at a specific site. These complex tests may include: Permeability tests on undisturbed foundation or compacted material, to determine the rate at which water moves through the soil; consolidation tests, to provide information for estimating the vertical movement

(Foreground) Atterberg soil-plasticity test; (background) hydrometer method for determining soil grain size.

or compression in an embankment or foundation and the horizontal movement in plastic foundations under dams; and shear tests, to determine the strength of embankment, backfill, and foundation materials.

Other laboratory tests also are made to meet special problems. Test and other information on a specific site is evaluated and analyzed, and included in reports making recommendations covering the soil-engineering aspects of the project.

During the 1959-60 fiscal year, 7,450 samples from about 470 projects were processed in the Lincoln laboratory and approximately 3,200 samples from nearly 350 sites were processed in the three testing sections, for a total of approximately 10,650 samples from more than 800 projects in 37 States and Puerto Rico. About 90 percent were flood-prevention and watershed-protection structures.

Hydrologists Keep Track of the Water

By R. G. Andrews

How water affects soil and water conservation work from the time precipitation falls as rain or snow until it returns to the atmosphere in the completed hydrological cycle is a matter of primary concern in farm and watershed conservation planning.

Dependable answers to water behavior and effects are of basic importance in locating and designing floodwater-retention structures in small watersheds, and in predetermining the water management aspects of various other conservation measures on farms and ranches. Soil Conservation Service hydrologists supply those answers to small-watershed organizations, farmer-organized and farmer-operated Soil Conservation Districts, and others with whom the Service is assigned responsibility to work in land use and water management improvement.

Hydrologic studies, like soil surveys and geological investigations, precede and are basic to sound planning of conservation structures and other works of improvement. They all directly help communities and group or individual landowners to avoid hit-or-miss project undertakings that otherwise might turn out to be unsatisfactory and costly.

Many of the latest concepts and theories of hydrology have resulted from interest in the effects of soil conservation land treatment and water management programs. The data collected by the soil conservation research stations (later transferred to the Agricultural Research Service) were used by the hydrologists to improve the tools of soil and water conservation and to develop new ones. Although many of these tools used today by conservation engineers and other conservation technicians are in the form of simplified charts, tables, maps, and graphs, they are based on extensive hydrologic data and computations.

The steadily increasing number of local-State-Federal flood prevention and watershed protection projects has greatly increased the demand for hydrologic information. SCS hydrologists are called upon to compute from meteorologic and watershed data a complete flood history of the watershed, including such pertinent facts as acreages subject to flooding. They also calculate acreages on which flooding would have been prevented if floodwater-retarding structures or channel work had been in place. Based on these findings, and the estimated cost of the structural measures, it is decided whether the proposed program is justified.

Note:—The author is head, Central Technical Unit, Soil Conservation Service, Beltsville, Md.

Engineering Aid Bill Thomas reads rain gage, one source of hydrologic data, near a damsite in Upper Hocking pilot watershed project in Fairfield SCD, Lancaster, Ohio.

The hydrologic design of floodwater-retarding structures requires, for example, that the detention storage capacity and floodwater-release rates be properly proportioned, so that the emergency spillway is not subject to destructive erosion. On the other hand, the release rates must not be so great that a large number of structures releasing water simultaneously will cause prolonged flooding or swamping of areas adjacent to stream channels.

The relationship between the detention storage, the maximum storage to the top of the dam (surcharge storage), and the capacity of the emergency spillway must be such that the runoff from the largest storm that can reasonably be expected in the area will not cause failure of the structure. These pieces must be fitted together like those of a jigsaw puzzle, to make sure that the floodwater-retarding structure will be built for the least amount of money and located at a site that will produce the most benefits.

If the storage of domestic or irrigation water is involved, the hydrologic problems that must be solved increase. The SCS currently is cooperating in the work of the U.S. river basin study commissions and river compact commissions, in municipal and irrigation water supply studies, and in other undertakings in this important field.

A question often asked is: "What effect will the land treatment, flood prevention, and watershed protection programs have on the available supply of water for downstream use at some specific date in the future?"

Preliminary studies indicate that there is no apparent reduction in downstream water yield as a result of this work, but a precise answer to a question of such broad import must await still more extensive soil and water conservation application than that which has been accomplished so far. Meanwhile, hydrologic investigations continue to be basic in the technology that is helping to conserve the Nation's soil and water resources.

Bulbs Can't Stand Wet Feet

By Andrew Linn

DOES improved drainage pay in dollars and cents? "Yes," says Harold Knutson, well-known bulb grower in western Washington's Puyallup Valley.

While looking over a field of bulbs near his house where a complete tile drainage system was installed last year, he commented: "I lost 4 acres of bulbs in this 14-acre field one year because they drowned out."

Knutson, left, and Alfred Scholz in field of daffodils.

Ditch that will provide tile-drain outlet for Knutson's and four other farms.

Four acres of bulbs doesn't mean a few dollars, but thousands of dollars. The cost of certain plant ing stock can run from $1,000 to $1,500 an acre. This figure does not include preparing the ground, labor, fertilizing, and the other costs of getting an acre of ground into production.

Knutson farms 600 acres in the fertile valley near Sumner and Puyallup. Most of his efforts go into the production of iris, tulip, and daffodil bulbs. He also produces rhubarb and raises beef cattle.

He is a cooperator with the Pierce County Soil Conservation District. In the past 2 years, he has installed, with the technical help of the Soil Conservation Service, 7,800 lineal feet of tile, which has benefited 51 acres of valuable bulb land.

Up to the time the Pierce County district was formed in July 1949, there was little tile drainage in the Puyallup Valley. Now, farmers are realizing the importance of good drainage on their bulb and other cropland and are installing more tile systems each year. The Agricultural Stabilization and Conservation Committee usually shares up to half the cost of this permanent conservation practice, and the SCS is responsible for the technical phases.

Experience in an area and basic design criteria enable the technician to determine the diameter, depth, and spacing of a tile system. For example, a sandy soil will allow water to filter through easier and faster than a clay soil, thus allowing wider spacing between the lines. A tile line must have a minimum cover adequate to protect it from heavy machinery and tillage operations. Shavings, sawdust, or wood chips are filled in the trench 10 to 12 inches above the top of the tile, and soil is then backfilled over the filter material.

SCS technicians stake, survey, and design the drainage system. When the contractor moves in, he is given the grades and cuts of all the tile lines to be installed in the field. The technicians also check the installation as the drain is laid, and, when the installation is complete, take compass bearings to describe the lines. A map of the installation is made and becomes a part of the landowner's conservation farm plan, so he can locate his tile lines in years to come with such simple tools as a compass and tape measure.

In Pierce County, the completely installed cost of a 6-inch tile line averages 60¢ a lineal foot. The quality of tile used in such a permanent installation must meet definite specifications. Cost of tile drainage can range from $50 to $250 an acre, depending upon the field conditions.

Laying tile in freshly dug trench.

An improved 14-acre bulb field after heavy rains with no water damage.

Knutson, finding himself in need of new bulb ground, recently located a farm which, because of poor drainage, was used for some pasture and shallow-rooted vegetables. After consulting the SCS on its drainage improvement possibilities, he bought the place and is starting drainage improvement as part of his conservation program that will enable him to grow bulbs successfully. In order to do this, he needed a large ditch which would outlet through five farms. The arrangement was worked out through cooperation with his neighbors and the ASC office in a pooling agreement. Next year, he will start installing a system of tile feeder lines to the main drain ditch.

When asked what this improved water management means on this farm in dollars and cents, Knutson said: "Bulbs were tried on this placed several years ago and the farmer lost heavily. Without this ditch the place is worthless."

◆

"Land Use in a Changing Agriculture" is the theme of the 16th annual meeting of the Soil Conservation Society of America at Purdue University, Lafayette, Ind., July 30-August 2, 1961.

◆

National Farm Safety Week is being observed July 23-29, 1961.

Note:—The author is agricultural engineer, Soil Conservation Service, Snohomish, Wash.

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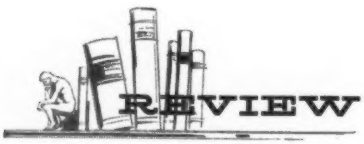

LAND, WATER & PEOPLE—A HISTORY OF THE NATIONAL ASSOCIATION OF SOIL CONSERVATION DISTRICTS. By Otis Tossett, assisted by Joe Douthit. 143 pp. Illus. 1961. The Soil Conservation Districts Foundation, Inc.: League City, Tex. $3.

Two active participants in the nearly 25-year-old nationwide soil conservation districts program record key steps in "the history of a movement and an organization which plays a vital role in proper land use." In 10 chapters, the author sketches the development and operation of the National Association of Soil Conservation Districts and its Women's Auxiliary. The description of events is sufficiently complete to provide an understanding of what happened, the leading participants, and the underlying causes for organization of the NASCD. A 62-page appendix includes a statement of the objectives and policies of the Association, the cover and signatures on the organization's first constitution, a list of officers by years, and the programs of the 14 annual conventions from 1947 to 1960.

The primary job of the NASCD in helping individual districts increase their usefulness is described in categories including information and educational help and the "Program for Greater Service."

Several programs the national association has helped to develop are described. They include: Soil Stewardship Week, the Goodyear Contest on district operations, the Farm Equipment Dealer–District Program, land judging contests, the 4-H conservation program, conservation education with Boy Scouts, District newsletter contests, and others.

Special recognition is given to the late E. C. McArthur, first president of NASCD, the late President Waters S. Davis, Jr., and the late Dr. Hugh H. Bennett, first chief of the Soil Conservation Service.

One chapter, on "District Organization Summary," reviews the development of the model act which served as a basis for enactment of State soil conservation district laws between 1937 and 1947. Another chapter, on "Conservation Battlegrounds," describes several major issues relating to progress in conservation in which the work of the Association was the deciding factor.

This work should be useful to all who are interested in this subject vitally significant to our Nation's welfare, even though some events and leaders were overlooked or not known about by the author.

For an understanding of key happenings in the development of soil conservation districts, and key events and leaders in the evolution of the NASCD as the spokesman of progressive soil and water conservation farmers and ranchers throughout the Nation, this book should be of use not only to soil conservation district supervisors, directors, or commissioners, but to everyone concerned with soil and water conservation.

—T. L. Gaston

Have You Seen?...

• *Better Hunting and Fishing on Small Watershed Projects,* published by the Fish and Wildlife Service, with photographs and other material from the Soil Conservation Service. It explains how developments benefiting fish and wildlife can be incorporated into the planning of a small watershed project, and what Federal aid is available.

• *Conservation Help for Builders, Developers, and Contractors,* a new booklet prepared by the Virginia Association of Soil Conservation Districts. It describes the kinds of help available to builders from Virginia soil conservation districts, relates problems that may be encountered without conservation help, and gives some "ground rules" for builders to follow in eliminating those problems.

SOIL CONSERVATION

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